Title: ELECTRIC MACHINE
Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP
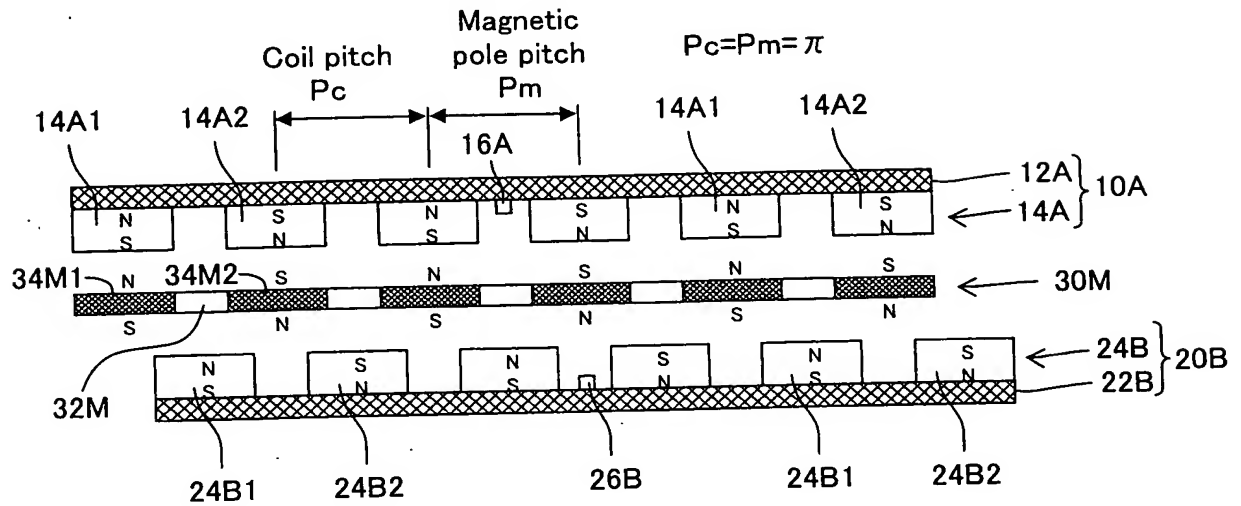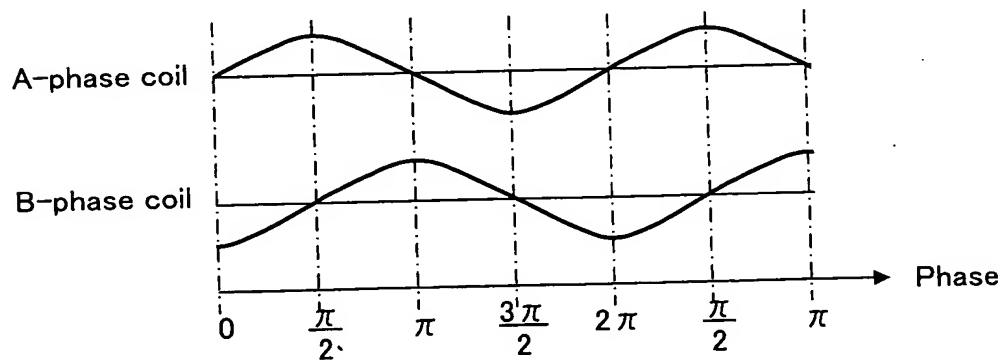
1/31

# Fig.1(A)

Configuration (comparative example)
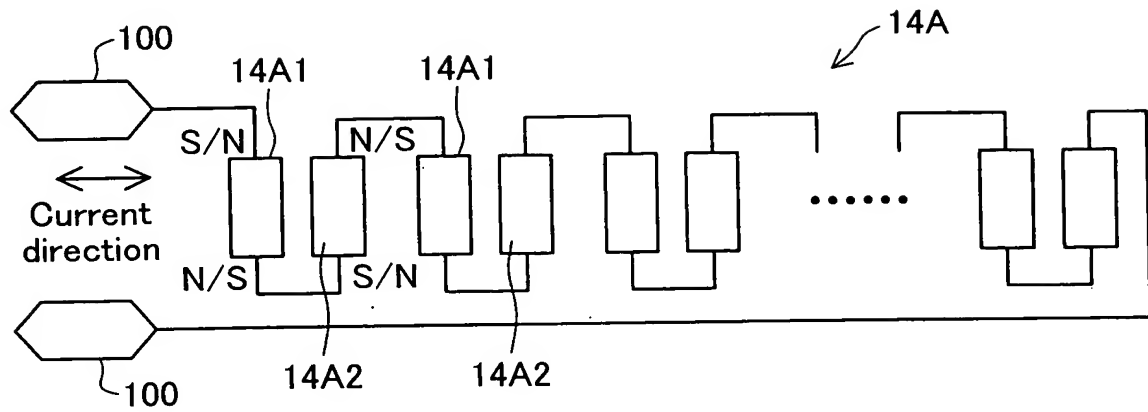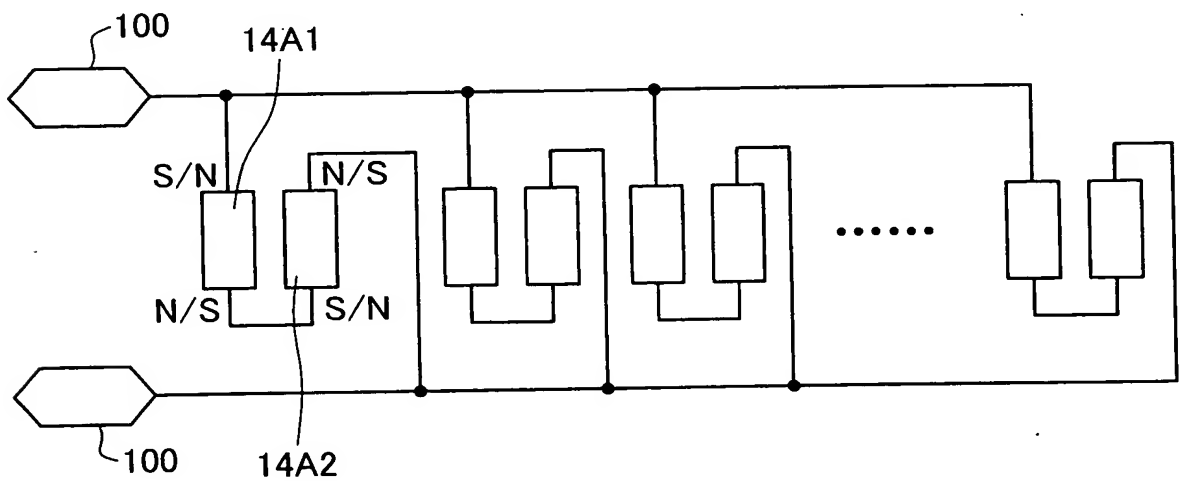


# Fig.1(B)

Alternating current drive signals

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Inventor(s): Kesatoshi TAKEUCHI, et al.
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Fig.2(A)



Fig.2(B)

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Inventor(s): Kesatoshi TAKEUCHI, et al.
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# Fig.3(A)

Comparative example
  Immediately before phase = $2\pi$ (A-phase has polarity reversed at $2\pi$)
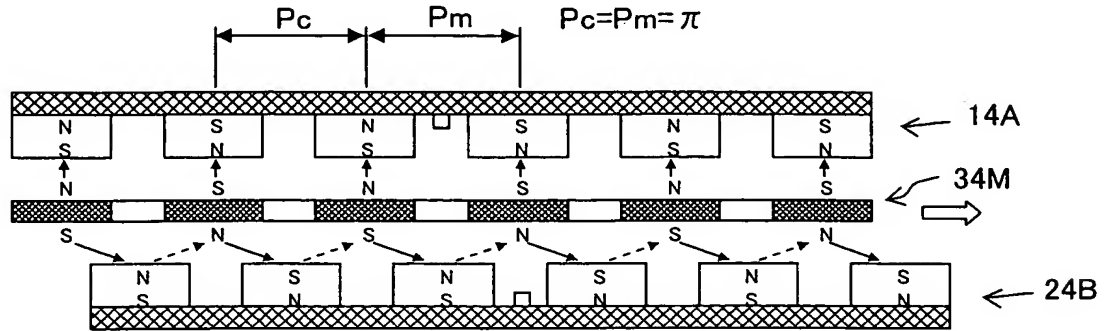


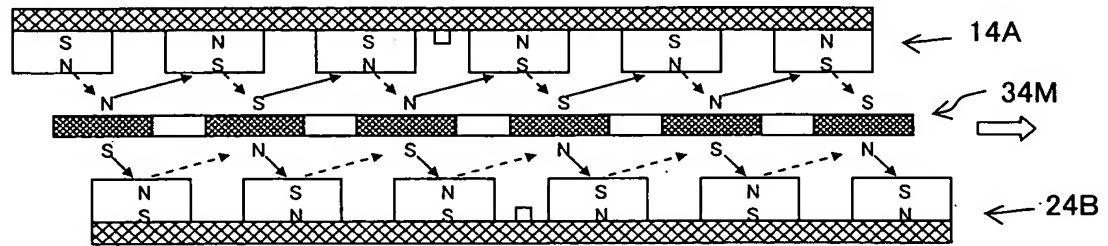# Fig.3(B)

Phase = $\pi/4$



# Fig.3(C)

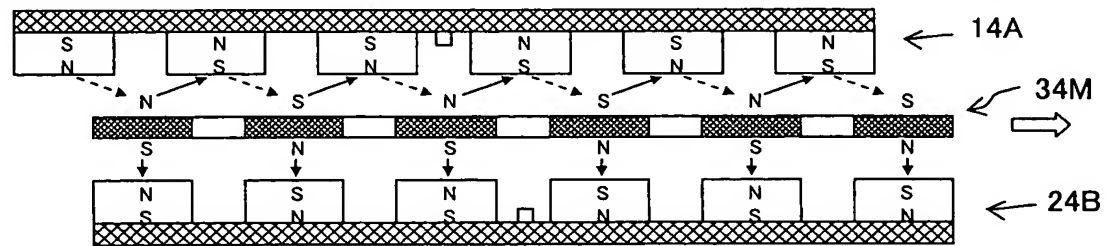Immediately before phase = $\pi/2$ (B-phase has polarity reversed at $\pi/2$)



# Fig.3(D)

Phase = $3\pi/4$

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# Fig.4(A)

First embodiment (two-phase motor)



# Fig.4(B)

Alternating current drive signals

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Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP

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## Fig.5(A)

First embodiment (two-phase motor)
    Immediately before phase = $2\pi$ (A-phase has polarity reversed at $2\pi$)

$D_c = 3P_m/2$

$P_m = \pi$

## Fig.5(B)

Phase = $\pi/4$

## Fig.5(C)

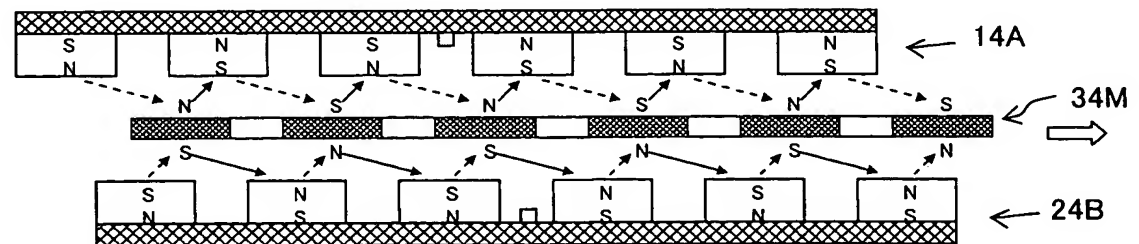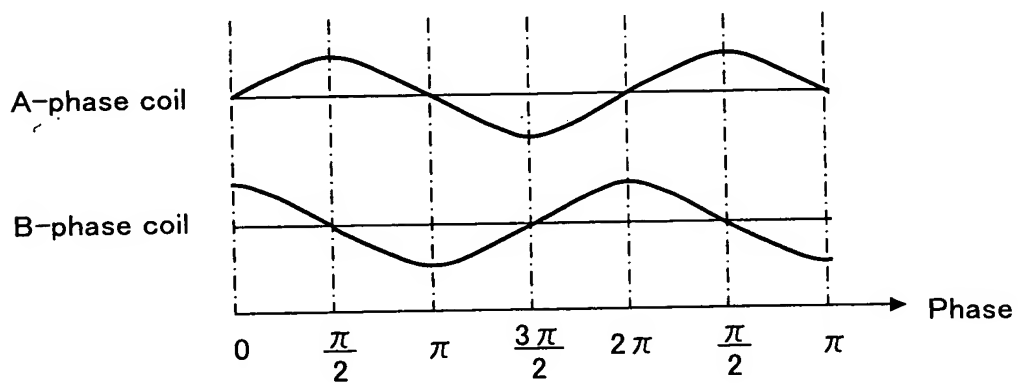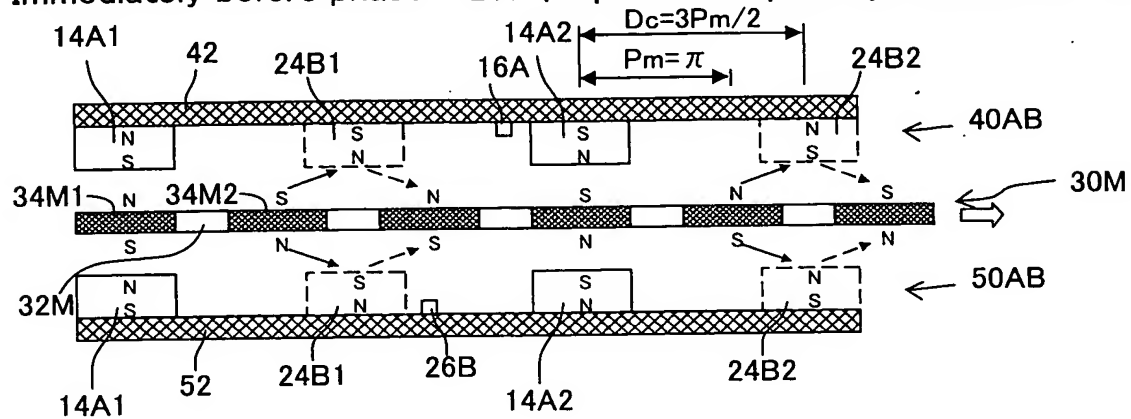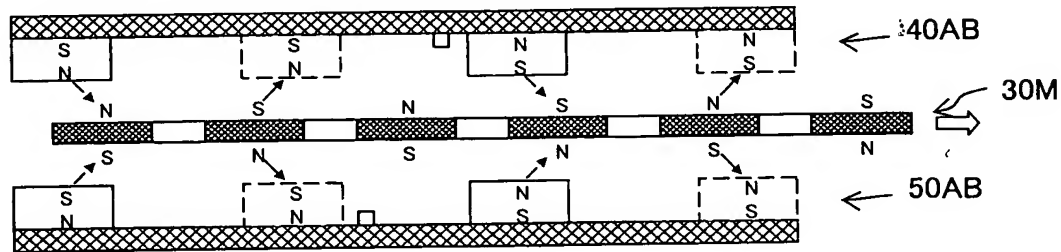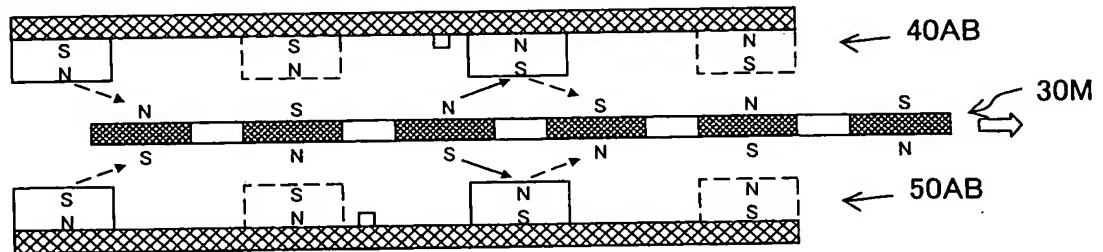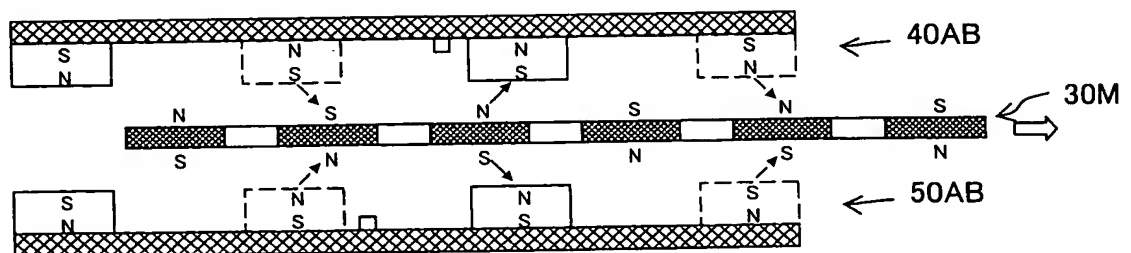Immediately before phase = $\pi/2$ (B-phase has polarity reversed at $\pi/2$)

## Fig.5(D)

Immediately before phase = $3\pi/4$

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# Fig.6(A)

Flat arrangement (example 1)



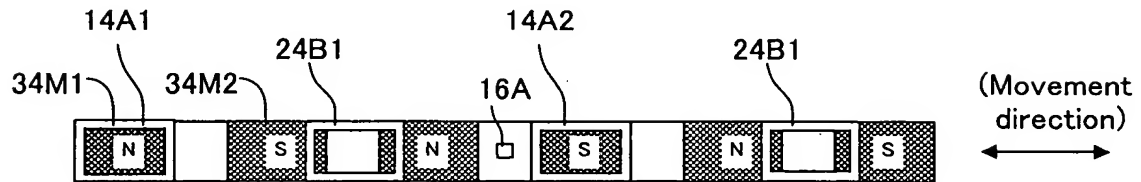# Fig.6(B)

Flat arrangement (example 2)

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Fig.7

500

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Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP
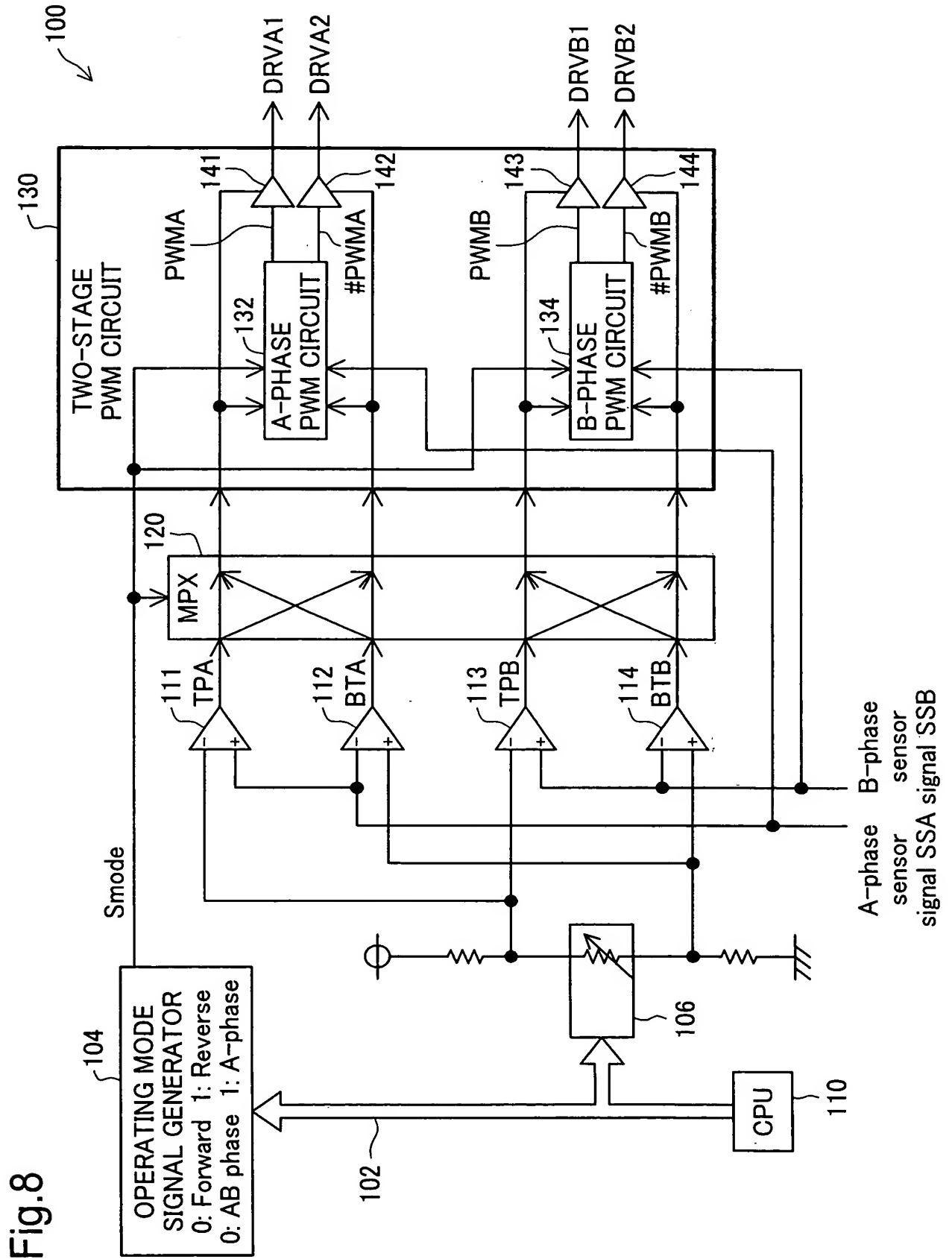
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Fig.8

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Fig.9

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Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP
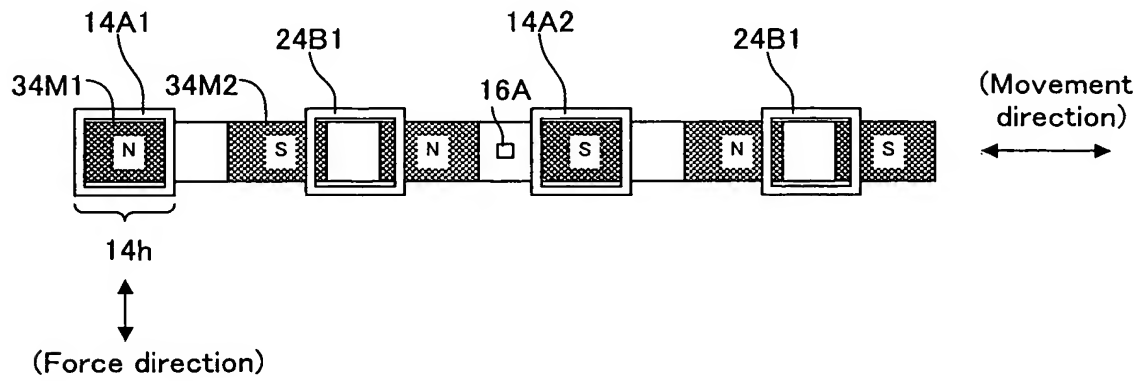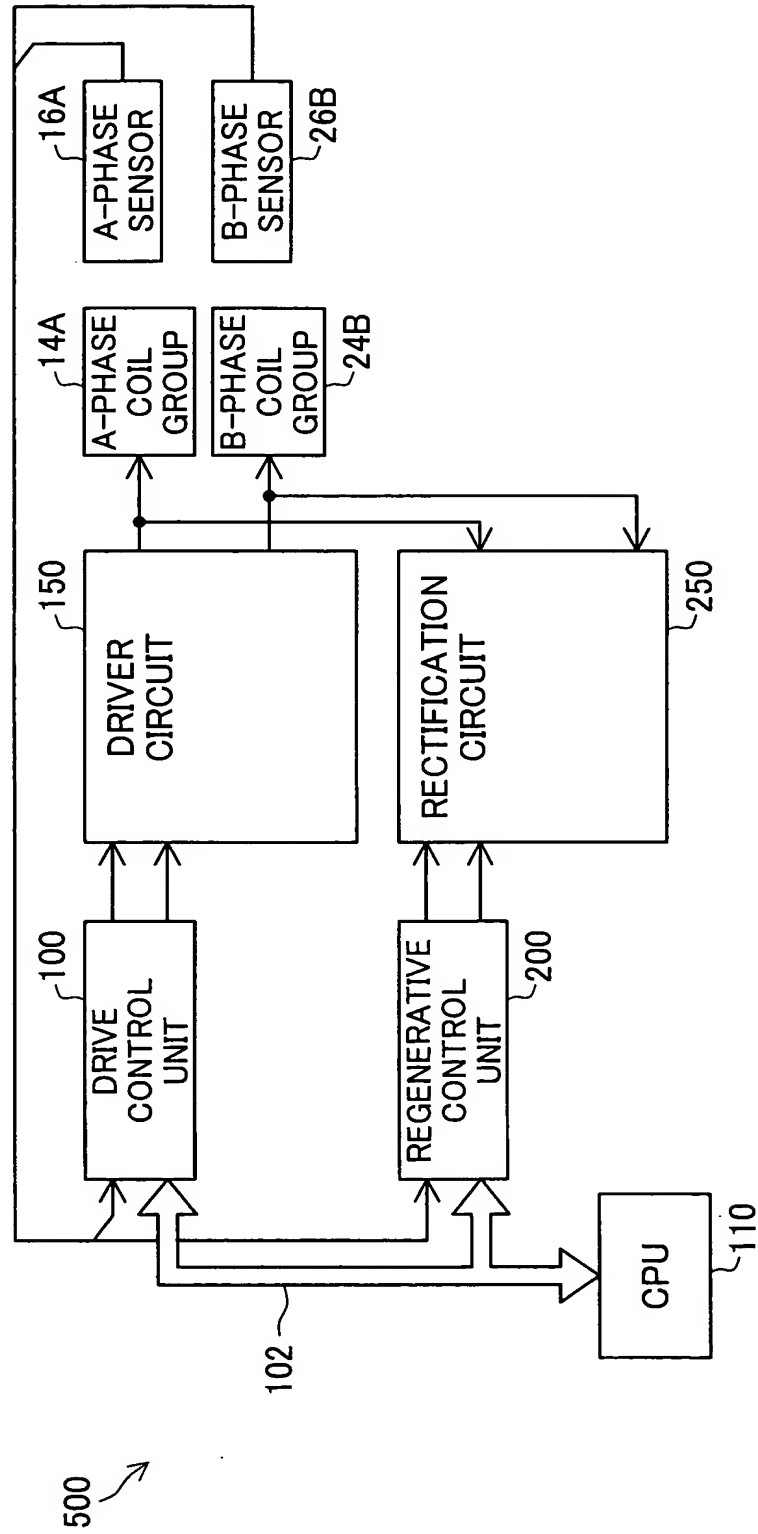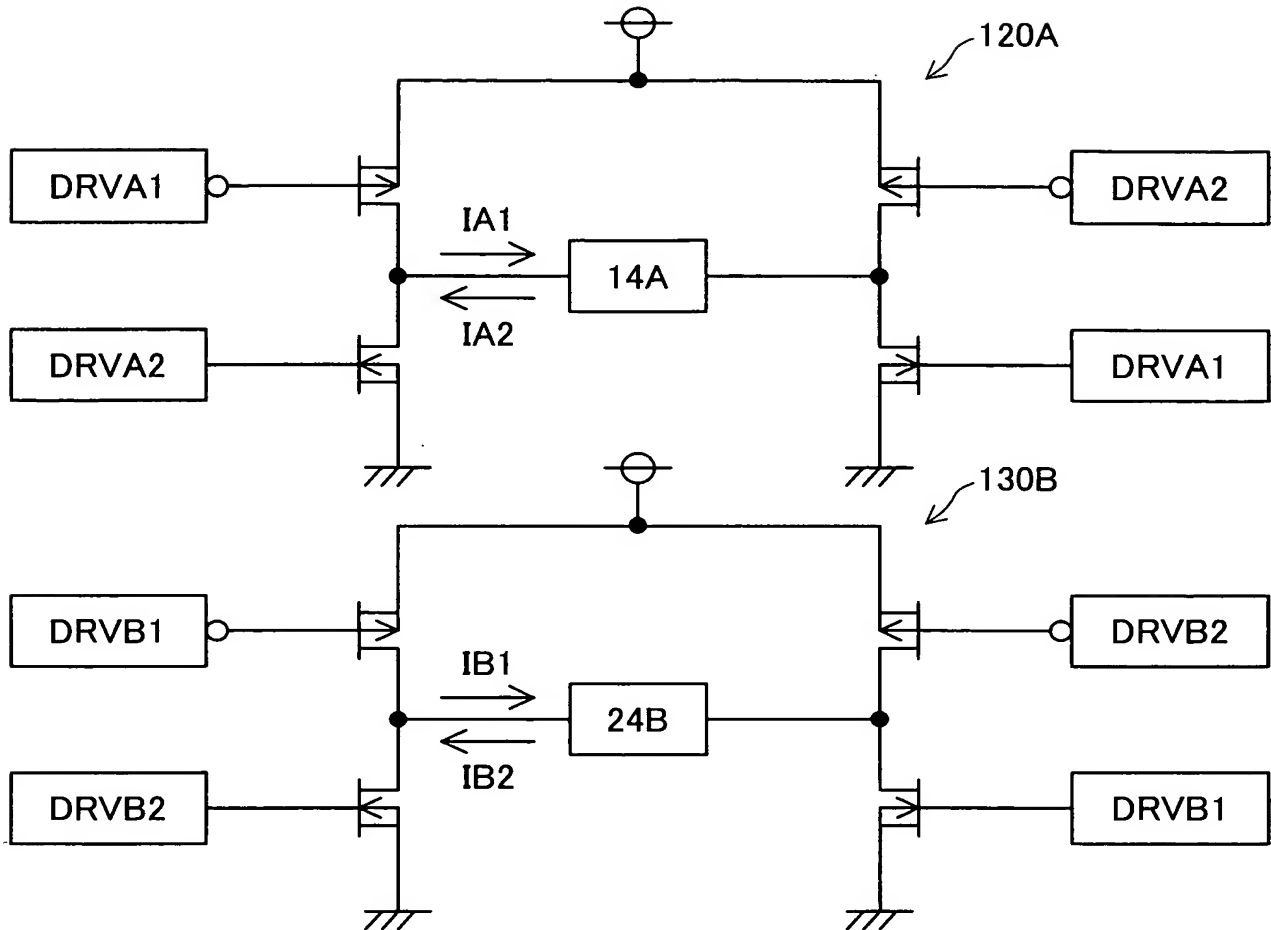
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# Fig.10

For large torque generation

Title: ELECTRIC MACHINE
Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP
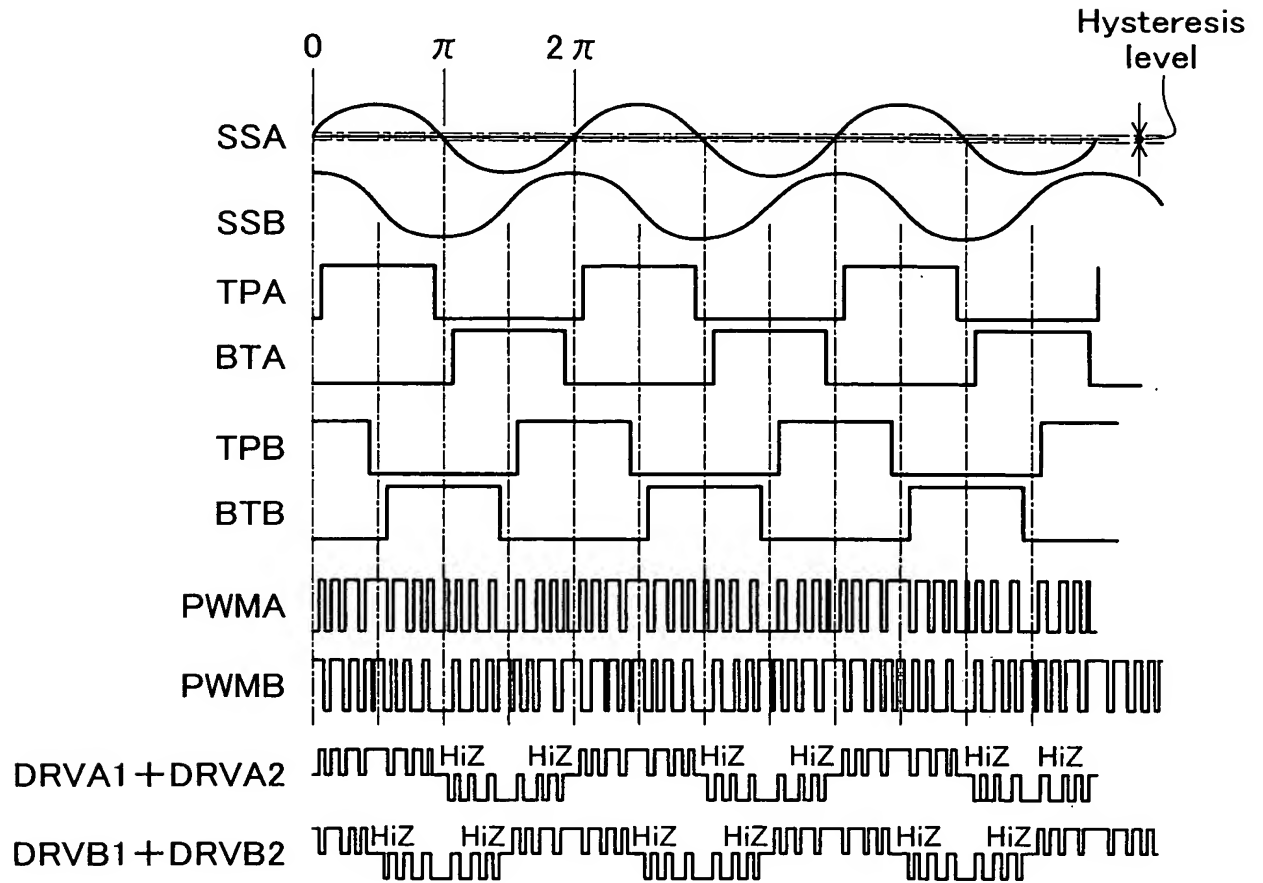
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# Fig.11

For small torque generation

Title: ELECTRIC MACHINE
Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP

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Fig.12

Title: ELECTRIC MACHINE
Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP
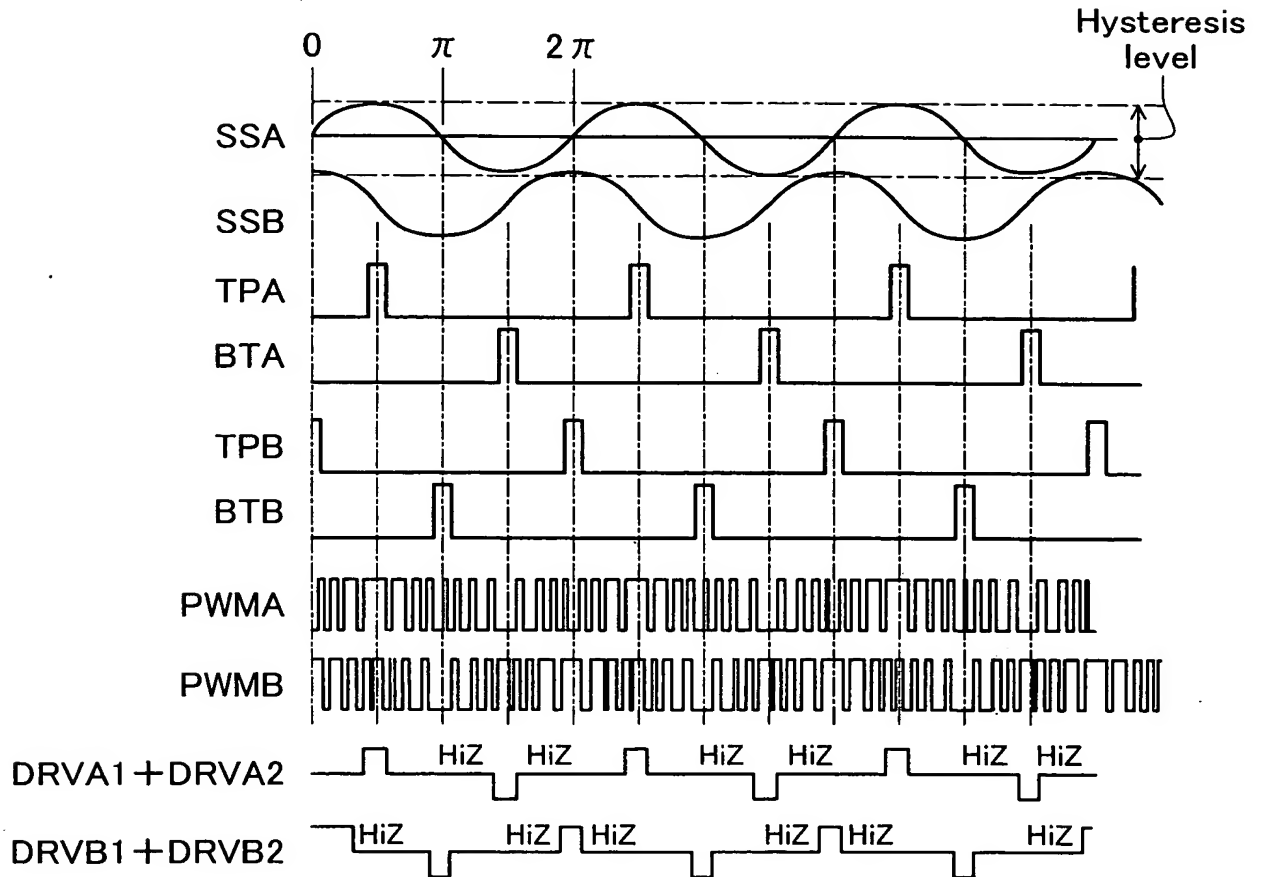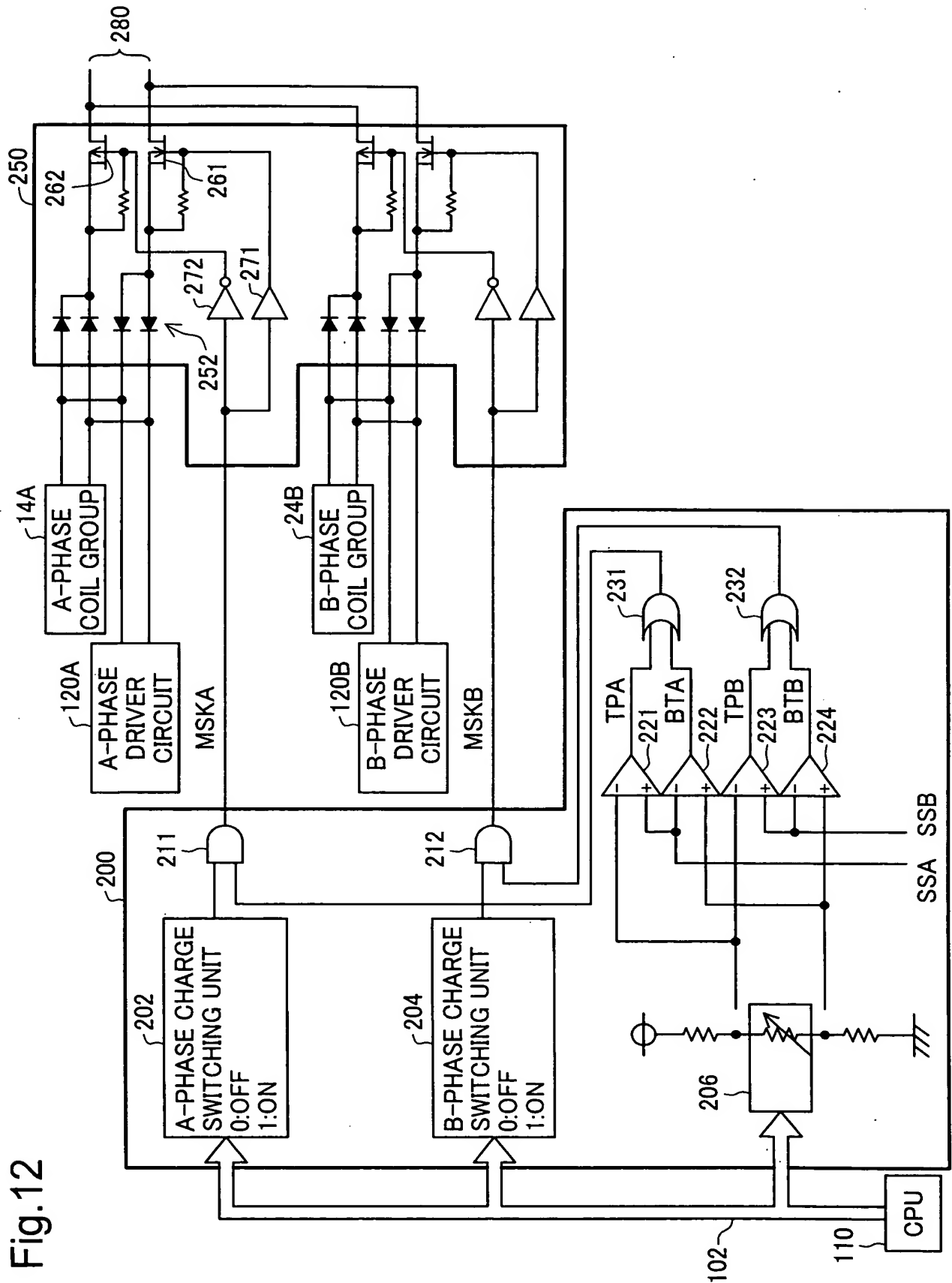
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## Fig.13(A)

Two-phase motor first variation example
Immediately before phase = $2\pi$ (A-phase has polarity reversed at $2\pi$)
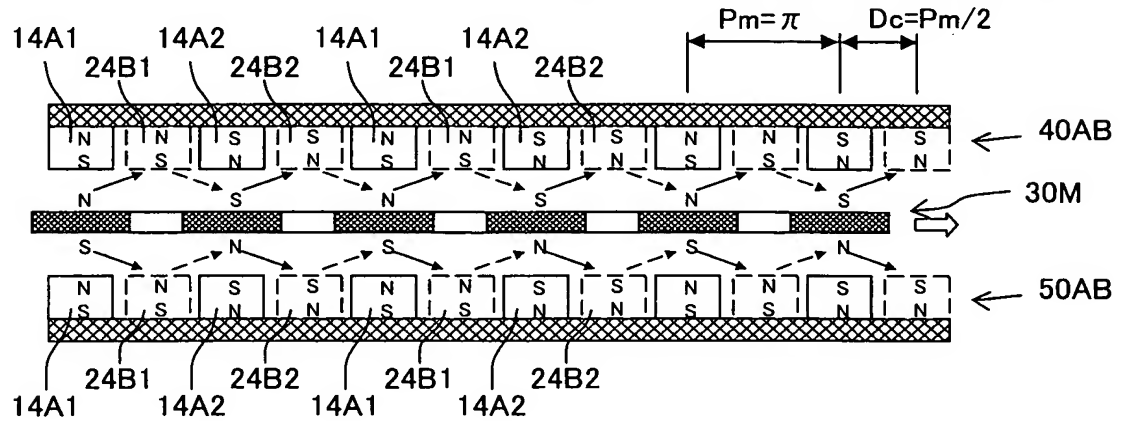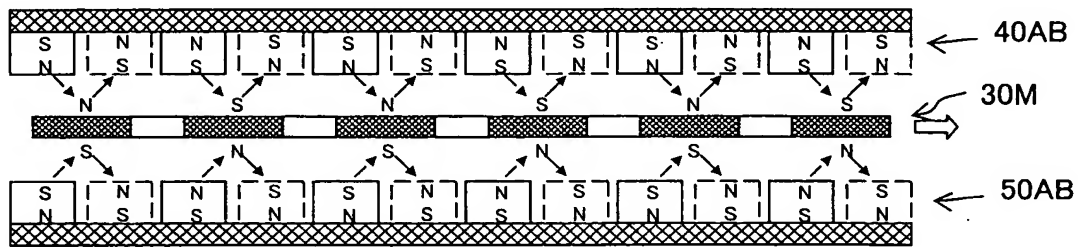


## Fig.13(B)

Phase = $\pi/4$



## Fig.13(C)

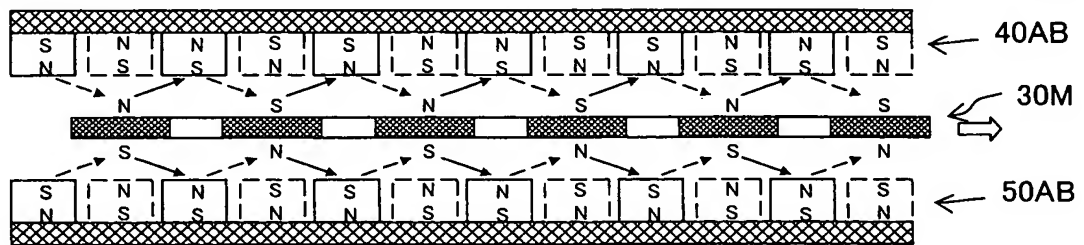Immediately before phase = $\pi/2$ (B-phase has polarity reversed at $\pi/2$)



## Fig.13(D)

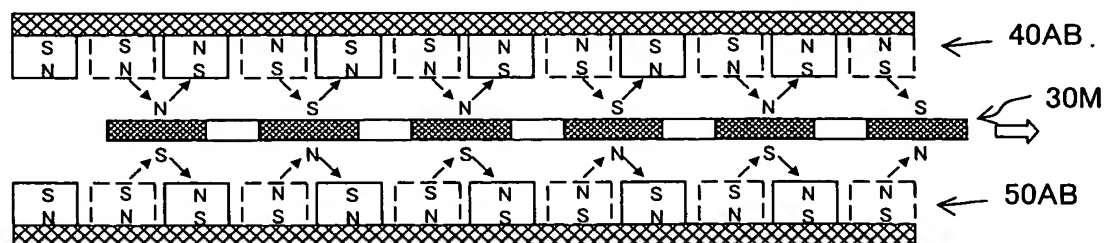Immediately before phase = $3\pi/4$

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Inventor(s): Kesatoshi TAKEUCHI, et al.
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## Fig.14(A)

Two -phase motor second variation example
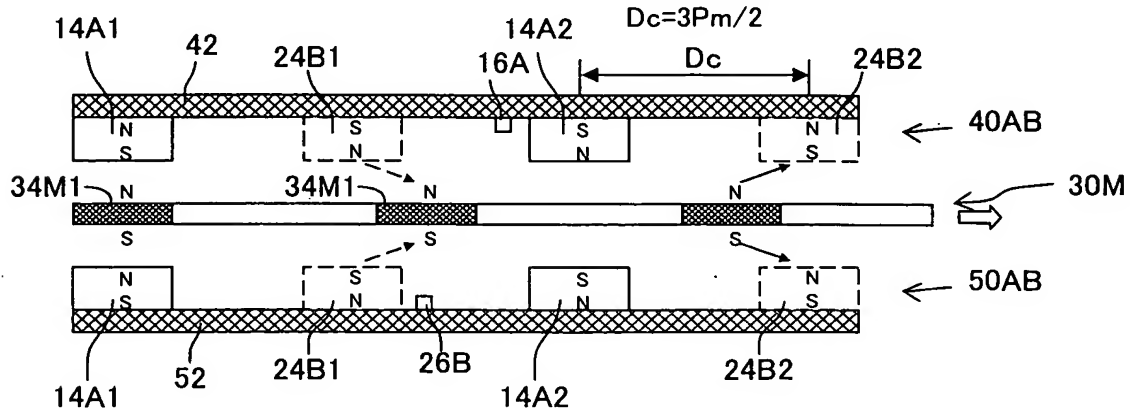Immediately before phase = $2\pi$ (A-phase has polarity reversed at $2\pi$)
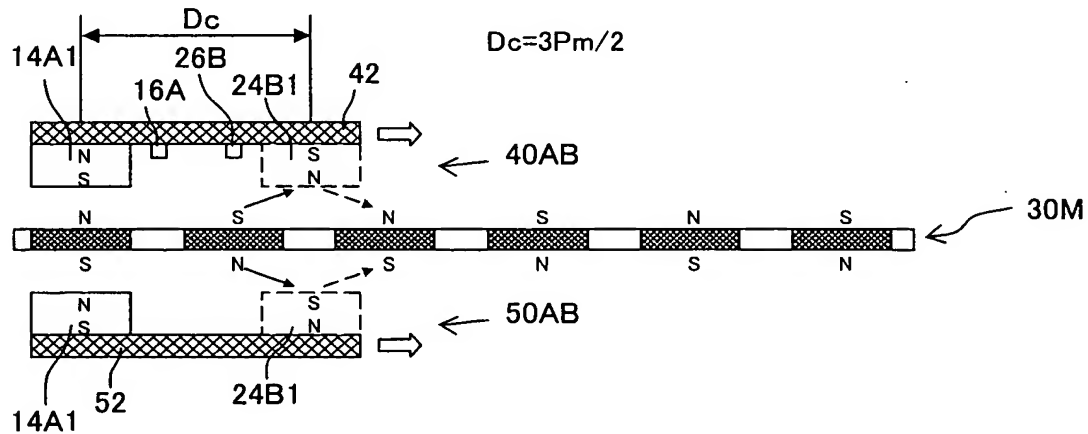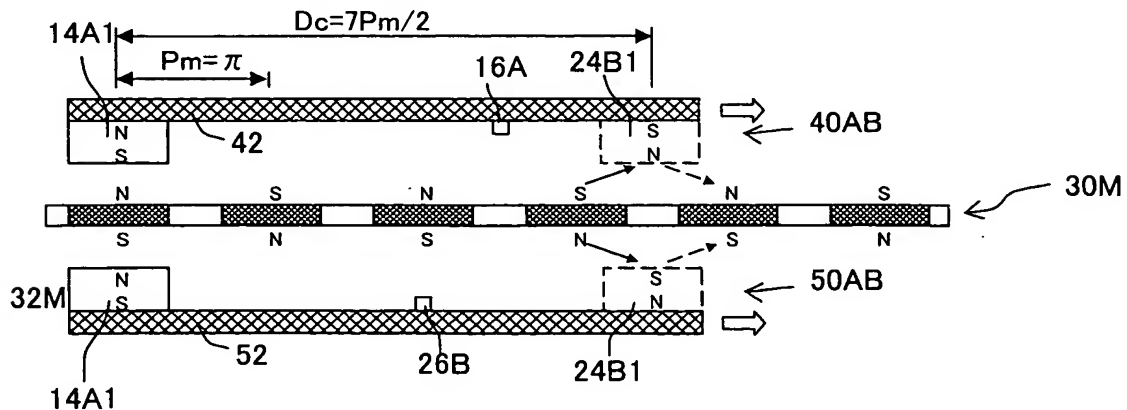


## Fig.14(B)

Two -phase motor third variation example



## Fig.14(C)

Two -phase motor fourth variation example

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# Fig.15(A)
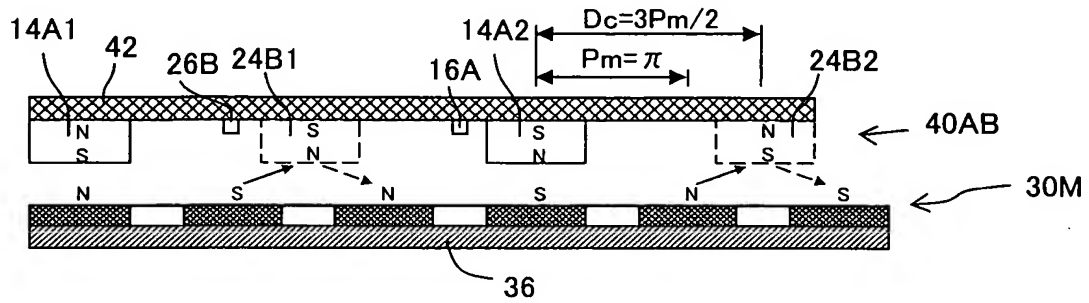
Two -phase motor fifth variation example (one sided arrangement)



# Fig.15(B)

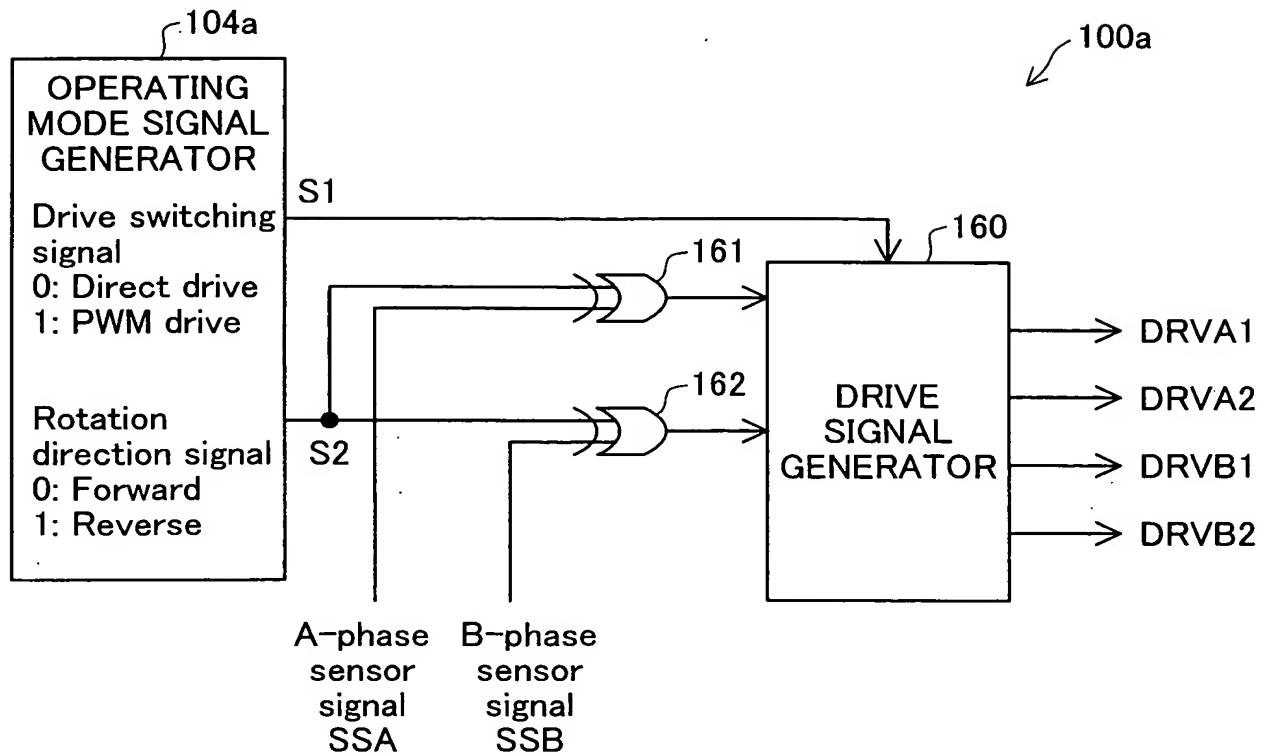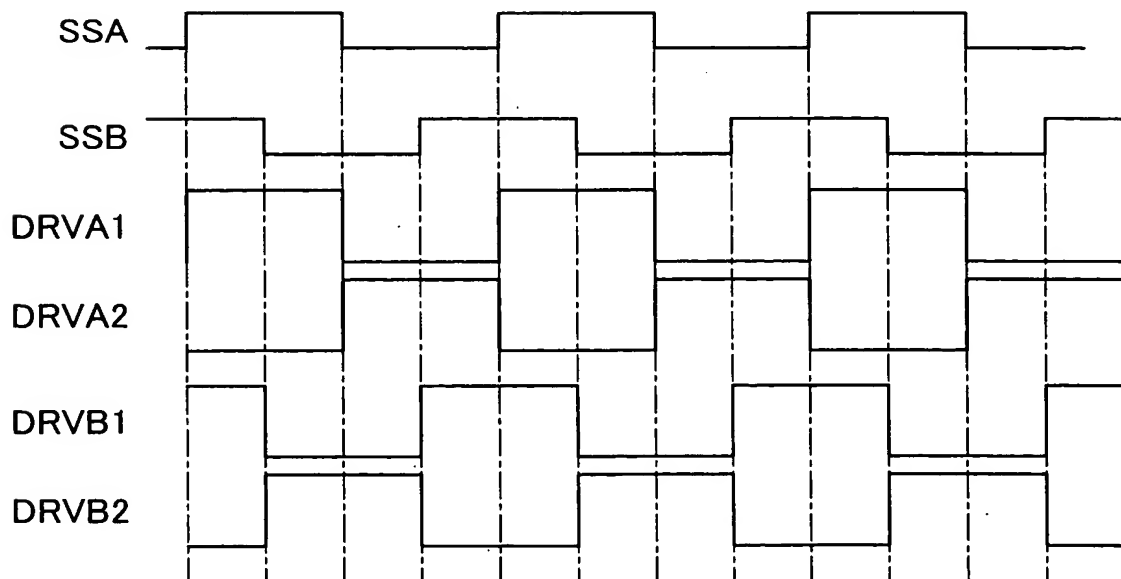Two -phase motor sixth variation example (one sided arrangement)

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Inventor(s): Kesatoshi TAKEUCHI, et al.
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## Fig.16

OPERATING
MODE SIGNAL
GENERATOR
`104a`

Drive switching
signal
0: Direct drive
1: PWM drive

S1

Rotation
direction signal
0: Forward
1: Reverse

S2

`161`

`162`

`100a`

`160`

DRIVE
SIGNAL
GENERATOR

→ DRVA1

→ DRVA2

→ DRVB1

→ DRVB2

A-phase
sensor
signal
SSA

B-phase
sensor
signal
SSB

## Fig.17

SSA

SSB

DRVA1

DRVA2

DRVB1

DRVB2

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## Fig.18



## Fig.19

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Fig.20

Title: ELECTRIC MACHINE
Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP
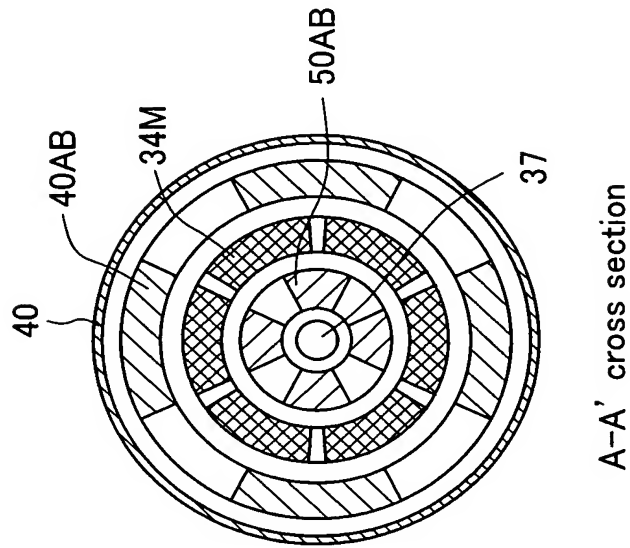
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Fig.21(B)

A–A' cross section

Fig.21(A)

Insert rotor structure (both sided arrangement)

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Inventor(s): Kesatoshi TAKEUCHI, et al.
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Fig.22(A)
Stator

Fig.22(B)
Rotor

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Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP
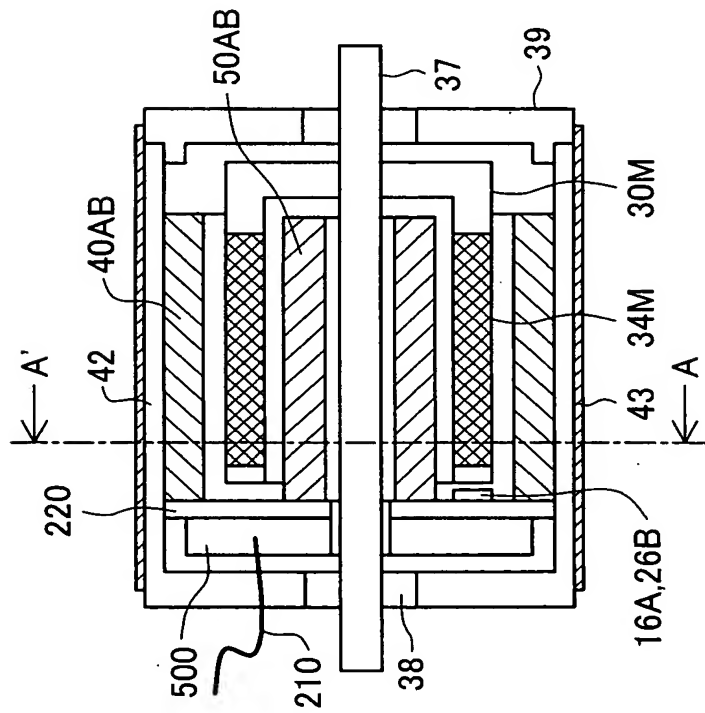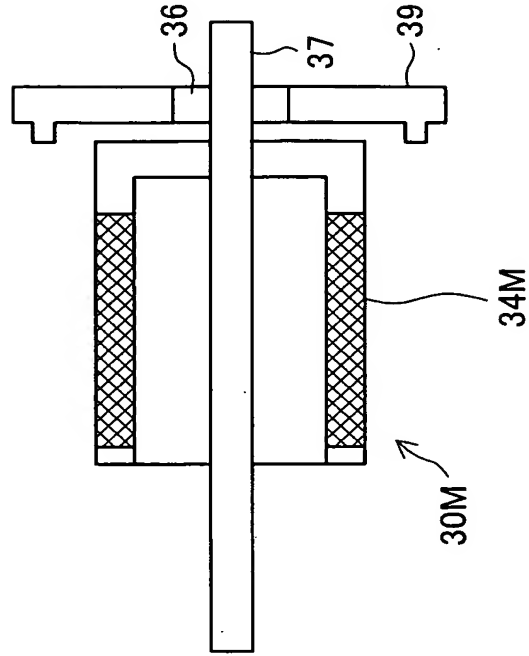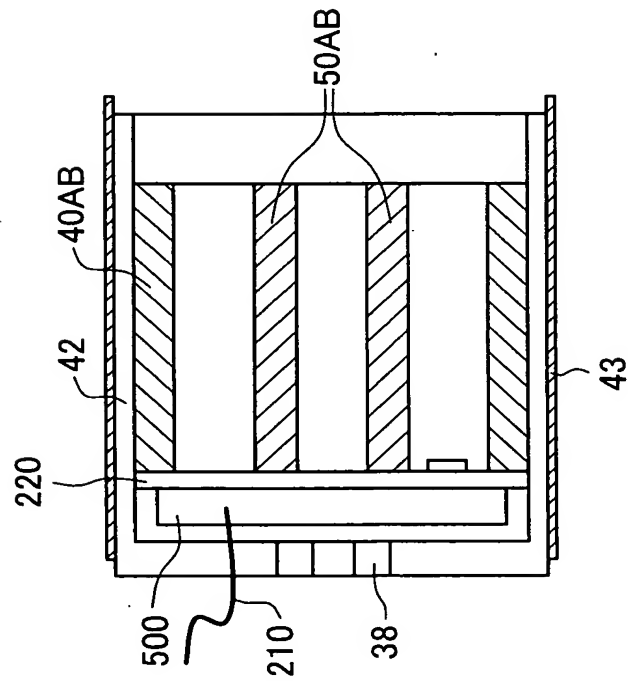
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Fig.23(A)

Inner rotor structure (one sided arrangement)

Fig.23(B)

A-A' cross section

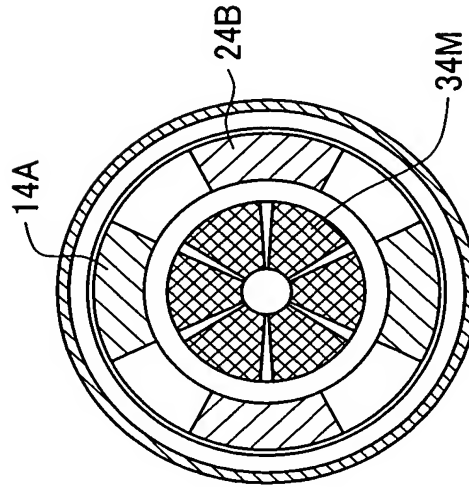Title: ELECTRIC MACHINE
Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP

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Fig.24(B)

24B

14A

34M

A-A' cross section
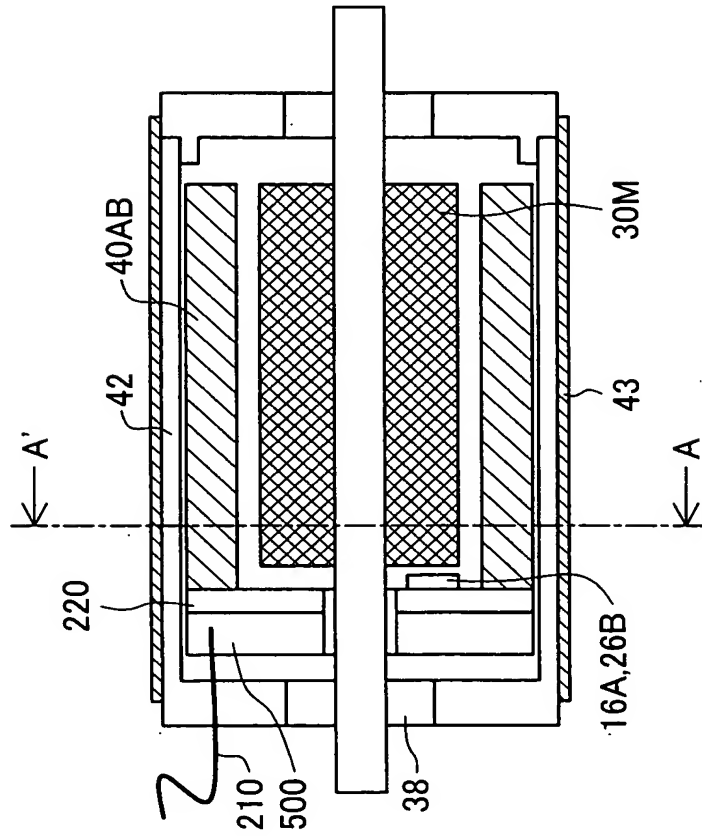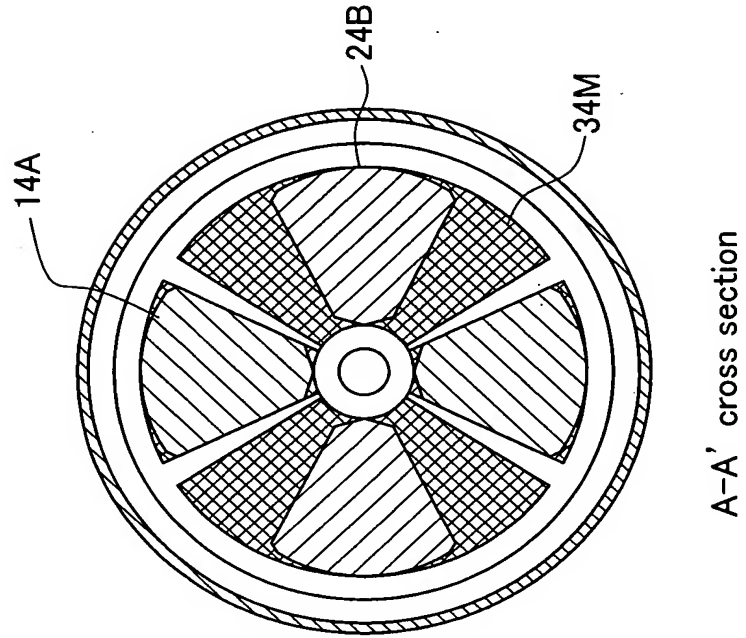
Fig.24(A)

Flat rotor structure (both sides arrangement)

50AB

40AB

220

210

500

38

16A,26B

30M

34M

A'

A

43

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Fig.25(A)

Flat rotor structure (one sided arrangement)

Fig.25(B)

A-A' cross section

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Inventor(s): Kesatoshi TAKEUCHI, et al.
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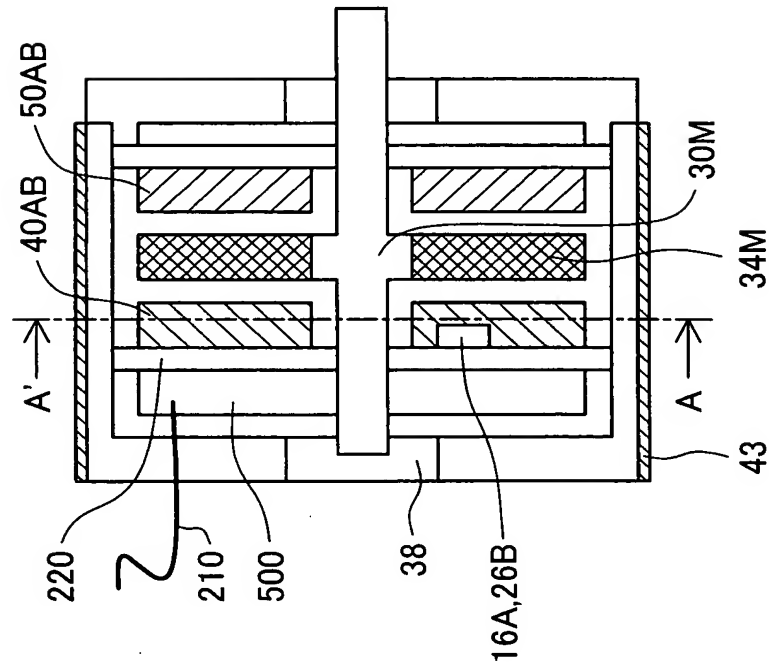
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## Fig.26(A)

Second embodiment (three-phase motor)
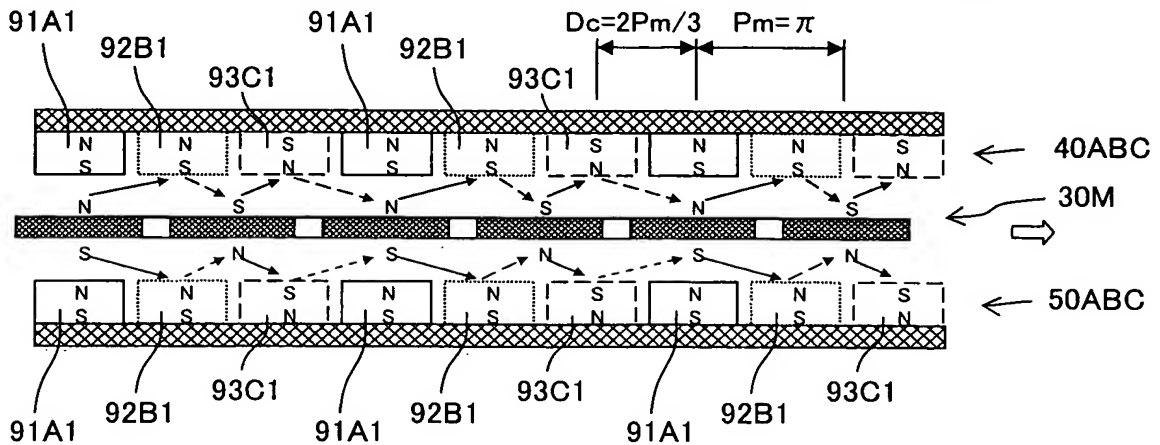Immediately before phase = $2\pi$ (A-phase has polarity reversed at $2\pi$)



## Fig.26(B)

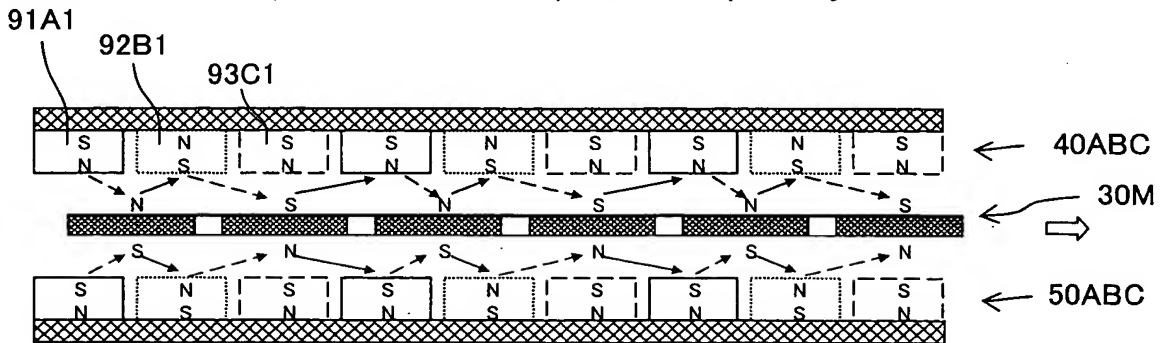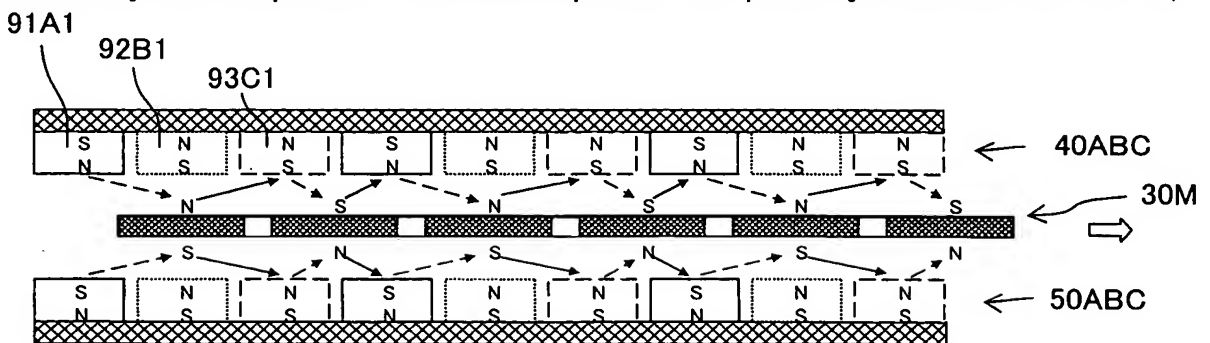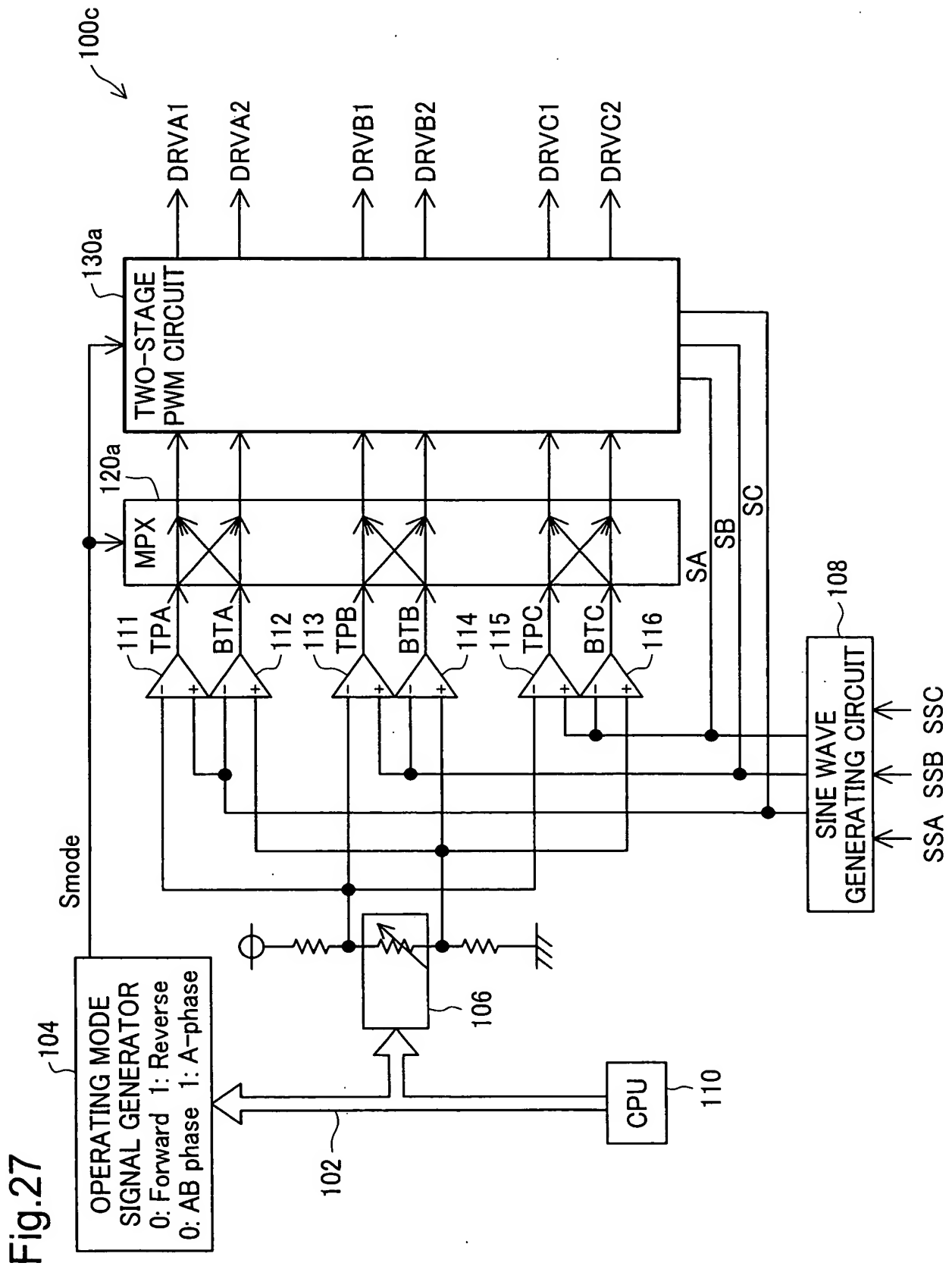Immediately before phase = $\pi/3$ (C-phase has polarity reversed at $\pi/3$)



## Fig.26(C)

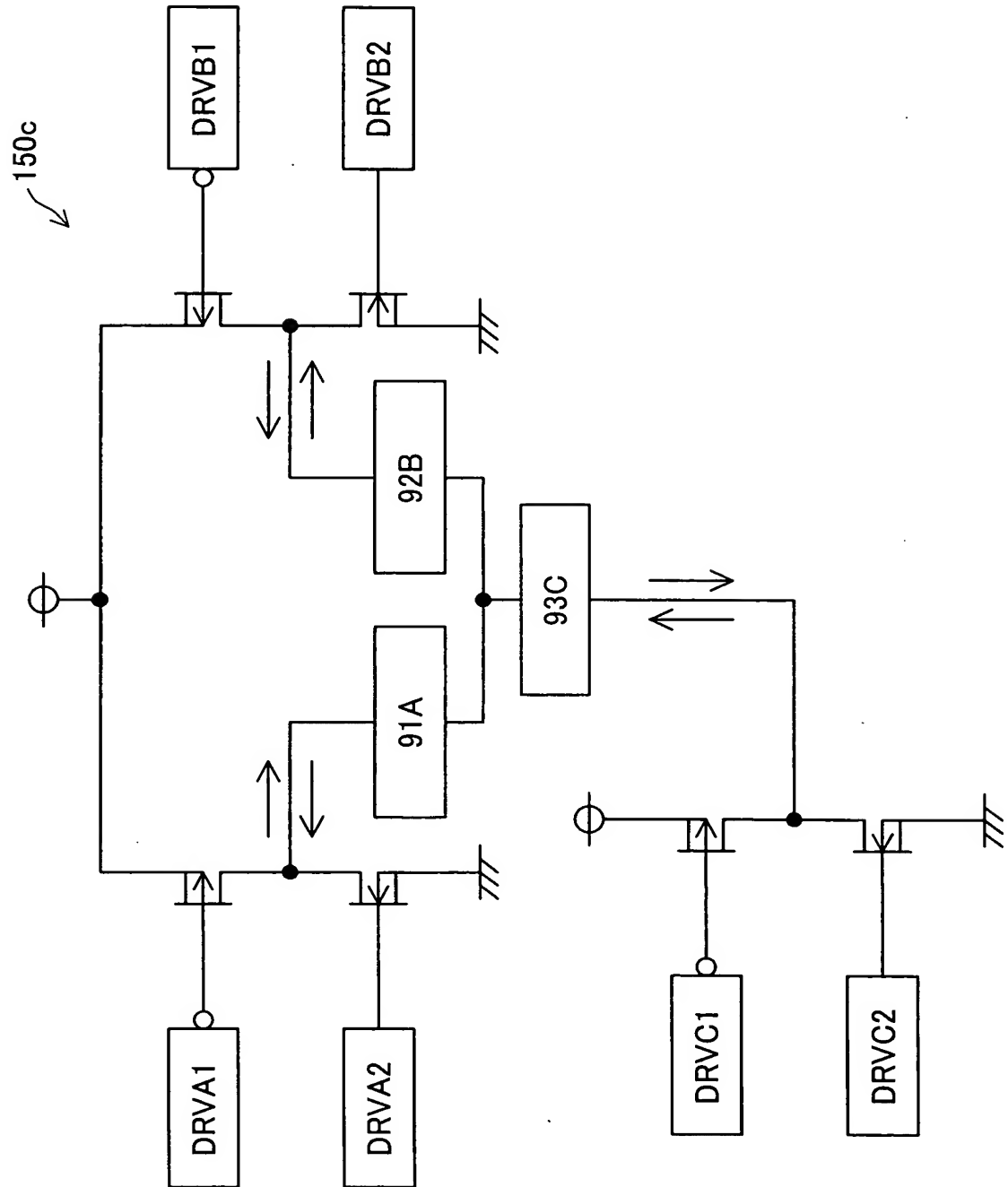Immediately before phase = $2\pi/3$ (B-phase has polarity reversed at $2\pi/3$)

Title: ELECTRIC MACHINE
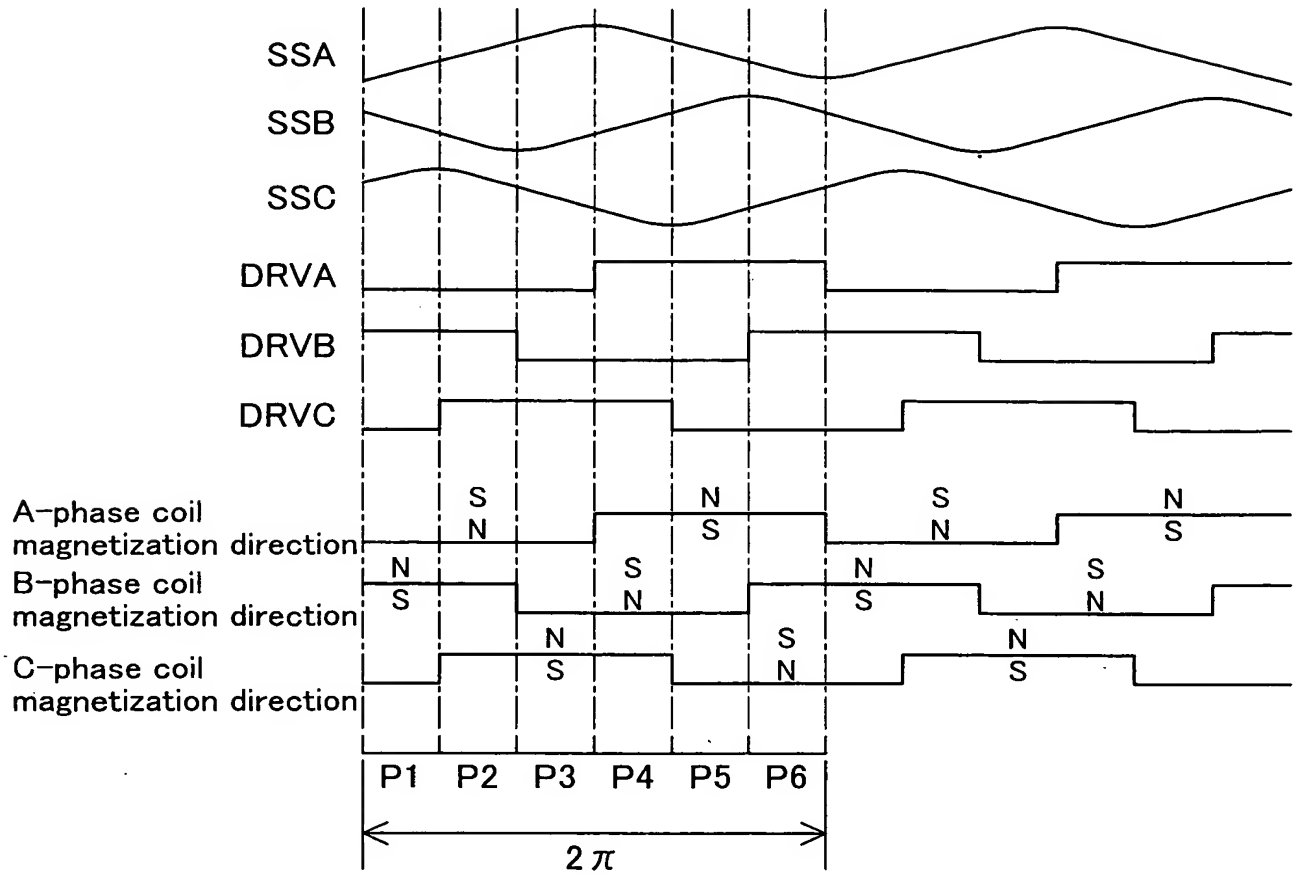Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP

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Fig.27

Title: ELECTRIC MACHINE
Inventor(s): Kesatoshi TAKEUCHI, et al.
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Fig.28

Title: ELECTRIC MACHINE
Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP

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# Fig.29

Three-phase timing chart

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## Fig.30(A)

Period P1

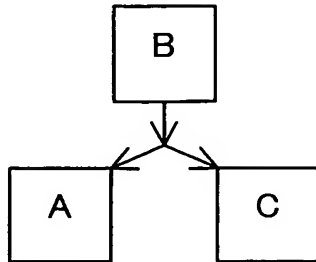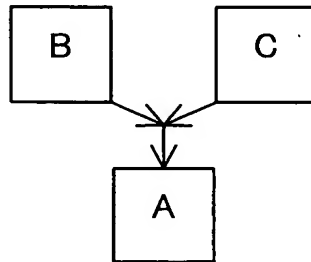## Fig.30(B)

Period P2

## Fig.30(C)

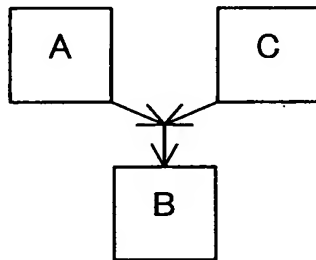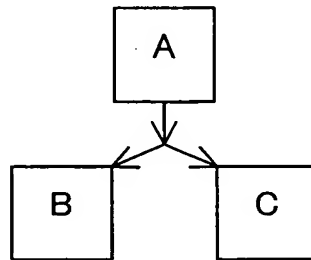Period P3
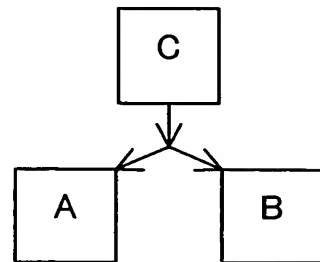
## Fig.30(D)

Period P4

## Fig.30(E)

Period P5

## Fig.30(F)

Period P6

Title: ELECTRIC MACHINE
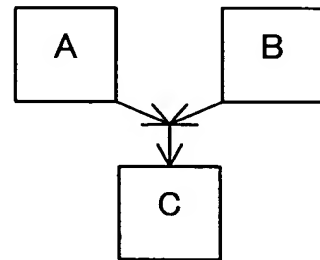Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP

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## Fig.31(A)

Third embodiment (four-phase motor)
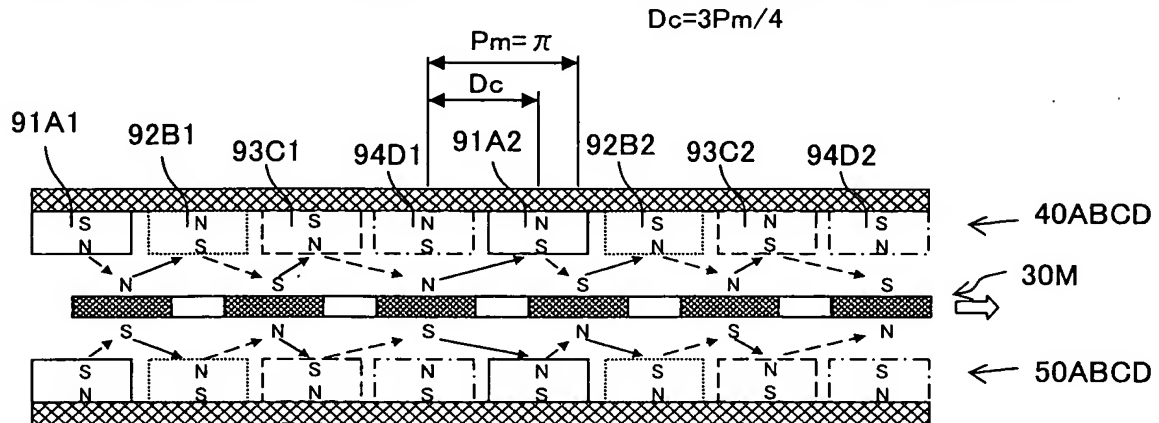Immediately before phase = $2\pi$ (D-phase has polarity reversed at $2\pi$)

Dc=3Pm/4

Pm=$\pi$

Dc

91A1 92B1 93C1 94D1 91A2 92B2 93C2 94D2

← 40ABCD

→ 30M

← 50ABCD

## Fig.31(B)

Immediately before phase = $\pi/4$ (C-phase has polarity reversed at $\pi/4$)

← 40ABCD

→ 30M

← 50ABCD

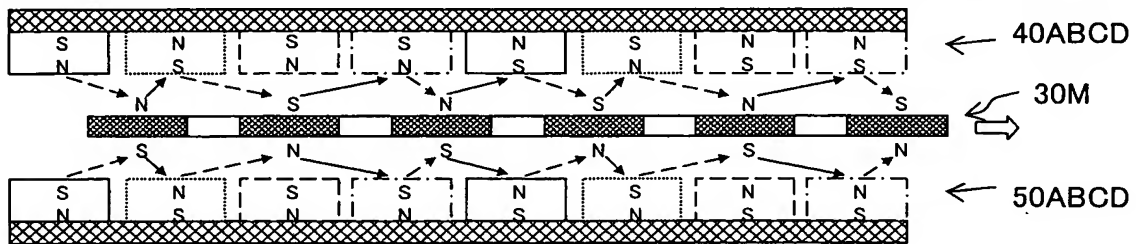## Fig.31(C)

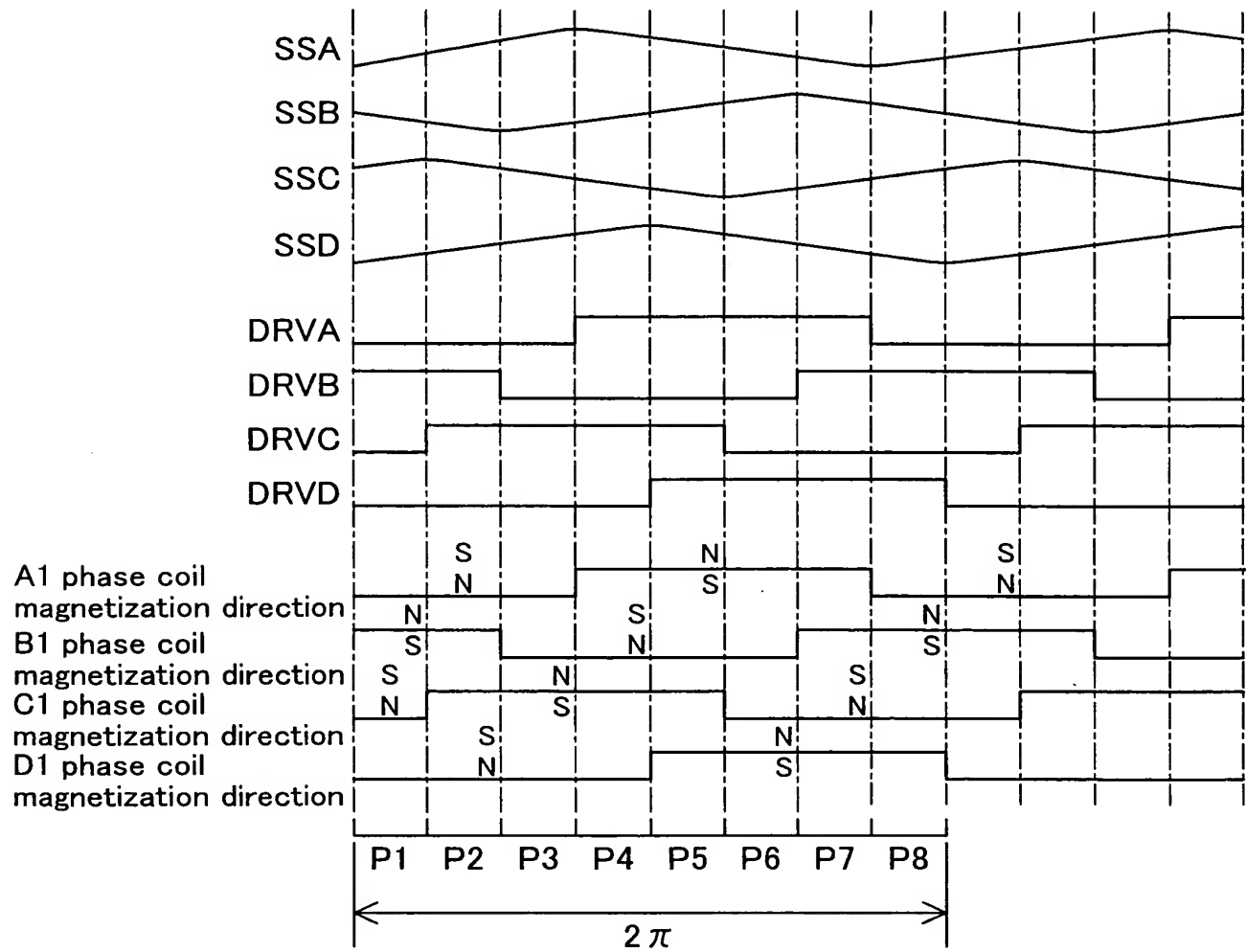Immediately phase = $\pi/2$ (B-phase has polarity reversed at $\pi/2$)

← 40ABCD

→ 30M

← 50ABCD
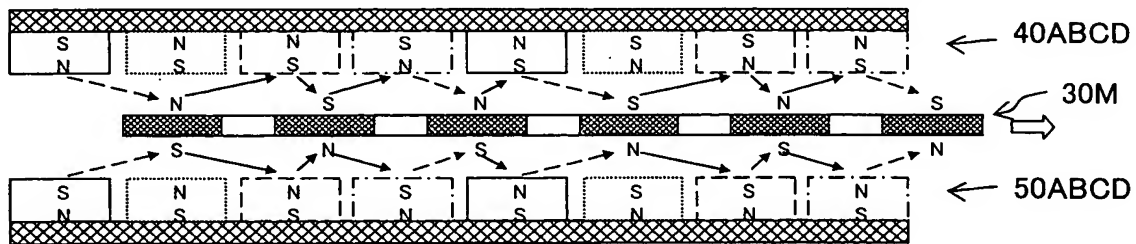
## Fig.31(D)

Immediately before phase = $3\pi/4$ (A-phase has polarity reversed at $3\pi/4$)

← 40ABCD

→ 30M

50ABCD

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Inventor(s): Kesatoshi TAKEUCHI, et al.
Atty. Ref.: 9319B-001456/US/NP
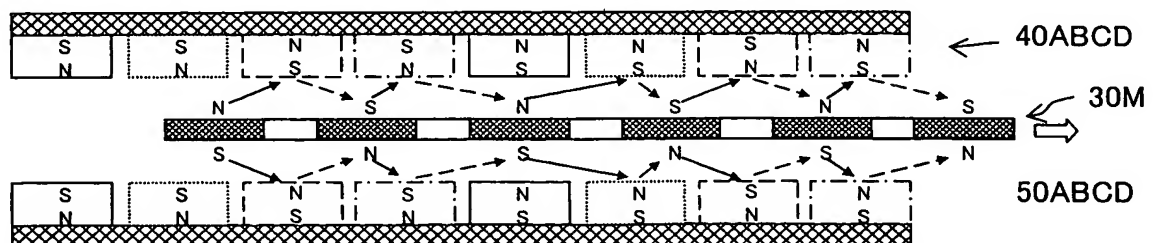
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# Fig.32

Four-phase timing chart

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Inventor(s): Kesatoshi TAKEUCHI, et al.
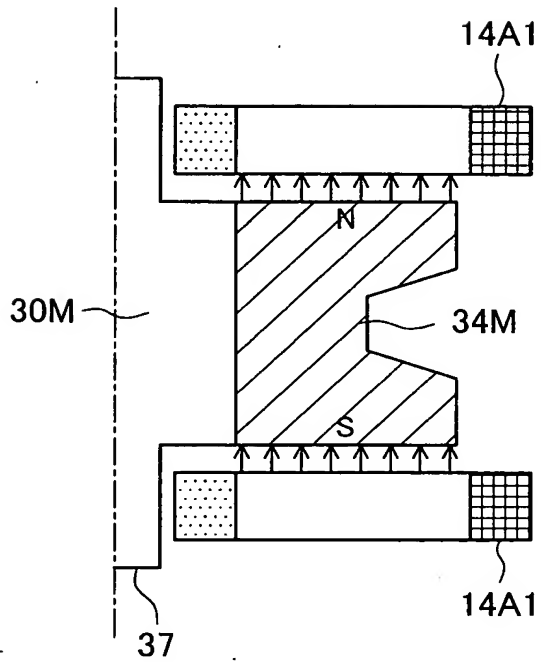Atty. Ref.: 9319B-001456/US/NP

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## Fig.33(A)

Flat ring shaped coil



## Fig.33(B)

Bent ring shaped coil